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QUARTERLY TECHNICAL REPORT ON
IMPROVEMENT OF ELECTRON TUBE TYPE USN-6J4WA

For the Period 11-1-53 to 2-1-54

Contract No. NObsr-57522

Report No. 4 March 23, 1954

SYLVANIA ELECTRIC PRODUCTS INC.
RADIO TUBE DIVISION
EMPORIUM PENNSYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
Radio Tube Division

Emporium, Pa.

FOURTH QUARTERLY REPORT ON DESIGN, DEVELOPMENT AND PRODUCTION OF TUBE TYPE USN-6J4WA

PERIOD COVERED:	Nov., Dec., 1953, Jan., 1954
DATE SUBMITTED:	March 29, 1954
CONTRACT NO:	NObsr-57522

Prepared by: C. D. Cherryholmes
Product Engineer

Submitted by: A. J. Heitner
Contract Coordinator

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RCA Victor Division
Harrison, New Jersey
Attention: Mr. G. G. Carne

TECHNICAL REPORT ON CONTRACT NObsr-57522
TUBE TYPE 6J4WA

This report is the fourth quarterly report on Contract NObsr-57522 and covers the work performed during the months of November and December, 1953 and January, 1954. The work on this contract is being performed in the Sylvania Receiving Tube Plant in Burlington, Iowa. It is the purpose of this contract to improve tube type 6J4WA for electrical and mechanical characteristics in order to produce a more reliable tube.

Production

25,955 good tubes were manufactured during this period at a total shrinkage of 49%. Control of grid to cathode spacing has been a continual problem. High shrinkage items are short circuits (11.2%) and plate current cutoff (7.8%) - both of which are results of incorrect spacing.

Jamming of grid laterals is a factor in short circuit shrinkage. However, this can be minimized by careful handling during manufacture and assembly. The largest percentage of jammed grids in finished mounts can be detected by visual inspection. The large flat cathode makes a visual inspection for grid-cathode spacing more of a problem than on other types. To determine the spacing that can be tolerated and, in many cases, whether the laterals are actually touching the coating at some point on the cathode becomes very difficult.

A check was put on the cathode shaver in the Filament Department whereby the unit is checked twice daily for mandrel position. This procedure should insure correct coating diameter and eliminate the possibility of eccentric coating.

In the past, a close control has been maintained on grid major, minor and cathode outside diameter. This has been followed by a continual tightening of the specified limits to not only insure parts within tolerances but as nearly centered as possible. Grid major and cathode O.D. are now limited to ± .0005". Cathode O. D. before shaving has been increased to insure an even coating diameter across the entire surface after shaving. A control of major and minor on this wide flat grid is extremely important, however, a detailed investigation of grid and cathode dimensions point out another factor which may be equally important. An oval shape condition has always been present to a certain degree in the 6J4 grid. Attempts have been made to keep the grid as flat as possible. A check indicates the varying physical properties (elongation, yield point, etc.) of the lateral wire has a pronounced effect on the set obtained when the grids are stretched. Because of this variation, grids with correct major and minor dimensions could be slightly oval resulting in very close spacing at the edge of the cathode which would cause high plate current cutoff and in some instances short circuit shrinkage. The following items will be investigated as a possible solution to this problem:

1. Change in grid lateral material to provide a better set in grid when stretched.
2. Continued work on present lateral material to obtain maximum stretch and set without breakage.
3. Shaver designed to scrape the coating from the edges of the cathode in order to provide protection when used with slightly oval shaped grids.

The finished mounts on this type are now being shadowscoped 100% for grid defects (grid to cathode spacing, jammed laterals and spread laterals). This is in addition to the final mount inspection previously performed.

Design and Life

The getterless tube design using a light carbonized bulb has been in production since the first of January. Four lots have been closed out since that time. Some concern has been shown about the shelf life of getterless tubes. The earliest production lot on which shelf life data could be obtained was sealed 12-16-53. These tubes were read February 9 which is seven (7) weeks from time of manufacture. The distribution of plate current, gas and transconductance for these is shown in Appendix A.

A complete summary of data obtained to date on the three cathode alloy tests (220, A30 and 499) is included in Appendices B through J. These are shown in comparison with M4 control alloy which is the material now being used in production.

220 Alloy This alloy exhibits slumping tendencies on life. Plate current and transconductance drop considerably after the 100 hour mark. Emission is lower than normal on tubes with getters and extremely low on getterless construction. This alloy is but slightly better for insulation resistance. Getterless tubes with M4 alloy cathodes are superior to 220 alloy with getters for this item.

A30 Alloy This material appears to be the most promising of the three alloys tested. Plate current, transconductance and emission are equal to, or higher than, the control. Insulation resistance with and without the getter are nearly identical, and the A30 alloy with getter is comparable to M4 (control) alloy without getter.

499 Alloy This is the most passive of the alloys tested. However, the plate current and transconductance are approximately the same as the control alloy.

The most marked difference is the very low emission values - averaging around 30 ma. on one test. Insulation resistance readings are very good on this alloy regardless of construction (with or without getter).

The initial test on getterless (clear bulb) construction has now completed 1500 hours life. The data on this test and the one with carbonized bulbs is plotted against a control of tubes with getter. This information is included in Appendices K through Q. The most significant points of variation between constructions are the heater-cathode leakage and insulation resistance (grid to all) readings.

One special five tube tray was constructed for a 6J6WA high temperature life test. Five current production tubes were burned in for 500 hours with rated life voltages applied and operated at 165° C ambient temperature. The averages for the five tubes at the intervals read are listed in the following table:

Hours	Plate Current Ma.	Gas Ma.	Emission Ma.	Transconductance μmhos	H-K Leakage μa. +	H-K Leakage μa. -	Ins. Res. K megohms P	Ins. Res. K megohms G
0	14.4	- .44	171	10,196	2.28	.76	299	56.6
50	12.1	- .28	149	9,440	3.98	1.29	300	81.6
100	13.0	- .21	143	9,658	2.70	1.16	294	82.4
250	13.0	- .26	143	9,400	.48	.83	300	72.5
500	12.0	- .11	142	9,188	.38	.83	270	35.0
	13.5 bogey	-6.0 max.		-8% 25%	20 max.	20 max.	.100 min.	.100 min.

The new construction without getter is vastly improved for insulation resistance and heater-cathode leakage as compared to tubes with getters. With getterless tubes it is important to seal fresh mounts and keep sealer sweeps clean and evacuation pumps in top condition. A slight amount of gas and low emission trouble is encountered if mounts are stored for a period of [illegible] days before being sealed. Use of a getter would provide the necessary protection against such conditions.

In view of the latter facts a return to a tube with getter will be considered as soon as a satisfactory cathode material can be obtained which will give results equal to the present type construction. Of the materials available to date, the A30 alloy appears to have the characteristics most desirable for this cathode - active material with low sublimation rate. A production run of 4000 A30 cathodes is now in progress (with getters). If this run is satisfactory a request will be made for additional cathodes of this alloy in production quantities to permit further evaluation and verification of shrinkage, design and life tests.

Elimination of the getter from the mount structure makes the use of a short bulb construction possible. Life tests are in progress using both clear and carbonized short bulbs. Tests are not complete but results to date are comparable to regular production with the medium length bulbs.

Mica for the new one-piece plate design have been received. A delay in tooling has made it necessary to advance the delivery date on the plates until April.

A summary of lots manufactured this quarter is contained in Table II. These lots are evaluated to the Sylvania Proposed Interim BuShips Specification of October 1, 1953.

TABLE I

Summary of Tubes Produced and Shipped

Contract AEUbs 57522

Month	Production
February, 1953	1,022
March, 1953	515
April, 1953	6,123
May, 1953	7,554
June, 1953	9,540
July, 1953	3,693
August, 1953	10,687
September, 1953	10,678
October, 1953	5,860
November, 1953	8,526
December, 1953	6,757
January, 1954	9,748
Total	80,703

Tubes shipped on contract to end of January, 1954 - 48,372

Contract calls for 100,000 unleased tubes

TABLE XI

QUARTERLY REPORT LOT STATUS - TYPE 6J4WA
November - December - January

Based on Proposed Interim BuShips Specification of 10-1-53

Lot	No	Attributes	Variables	Fatigue X	Shock	Heater Cycle	Stability Life	Survival Life	Intermittent Life	Thermal Shock	Status
JBM	2455	Acc[1]	Acc	--	Acc	Acc	Acc	Acc	Acc	Acc	Acc
JBN	1658	Acc[1]	Acc	--	Acc	Acc	Acc	Acc	Acc	Acc	Acc
JBQ	2906	Acc[1]	Acc	--	Acc	Acc	Acc	Acc	Acc	Acc	Acc
JBP	1904	Acc[1]	Acc	--	Acc	Acc	Acc	Acc	Acc	Acc	Acc
JBR	2118	Acc[1]	Acc	Rej	Acc	Acc	Acc	Acc	Rej[2]	Acc	Rej
JBS	588	Acc[1]	Acc	--	Acc	Acc	Acc	Acc	Acc	Acc	Acc
JBT	1246	Acc[1]	Acc	--	Rej[6]	Acc	Acc	Acc	100% @ 250 hrs.	Acc	Rej
JBU	1176	Acc[1]	Rej[4]	--	Acc	Acc	Acc	Acc	Not Completed[3]	Acc	Rej
JBV*	743	Acc	Acc	--	Acc	Not Completed	Acc	Acc	Acc	Acc	Not Completed
JBW	1139	Acc[1]	Rej[4]	Rej	Acc		Acc	Not Comp.	Not Completed[4]	Acc	
JBX*	2646	Acc	Acc	--	Acc		Acc		100% @ 250 hrs.	Acc	
JBZ*	226	Acc	Acc	--	Acc		Acc		100% @ 250 hrs.	Acc	
JCA*	2999	Acc	Acc	--	Acc		Acc		Not Completed[5]	Acc	

* Getterless Type Construction

Notes:

1 Accepted to 10 meg. limit of present specification
2 Rejected for heater-cathode leakage
3 Completed 250 hours 1-U30 and 1-U2 rejects

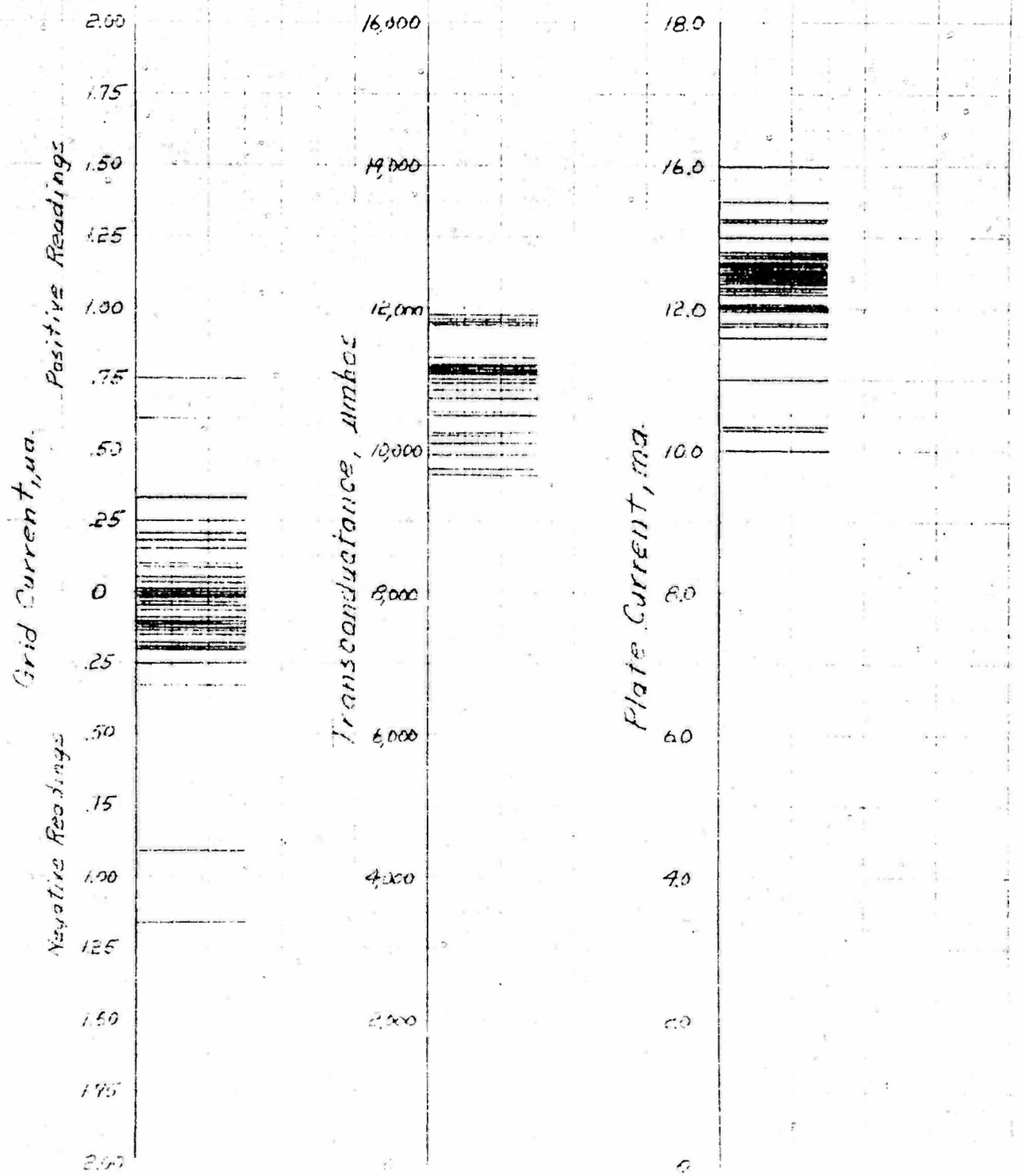
X Repeat test every 30 days after 1st lot acceptance
Lot JBK accepted

4 Completed 250 hours 1-U29
5 Completed 250 hours 1-U4
6 2nd sample awaiting post bridge readings

Appendix A

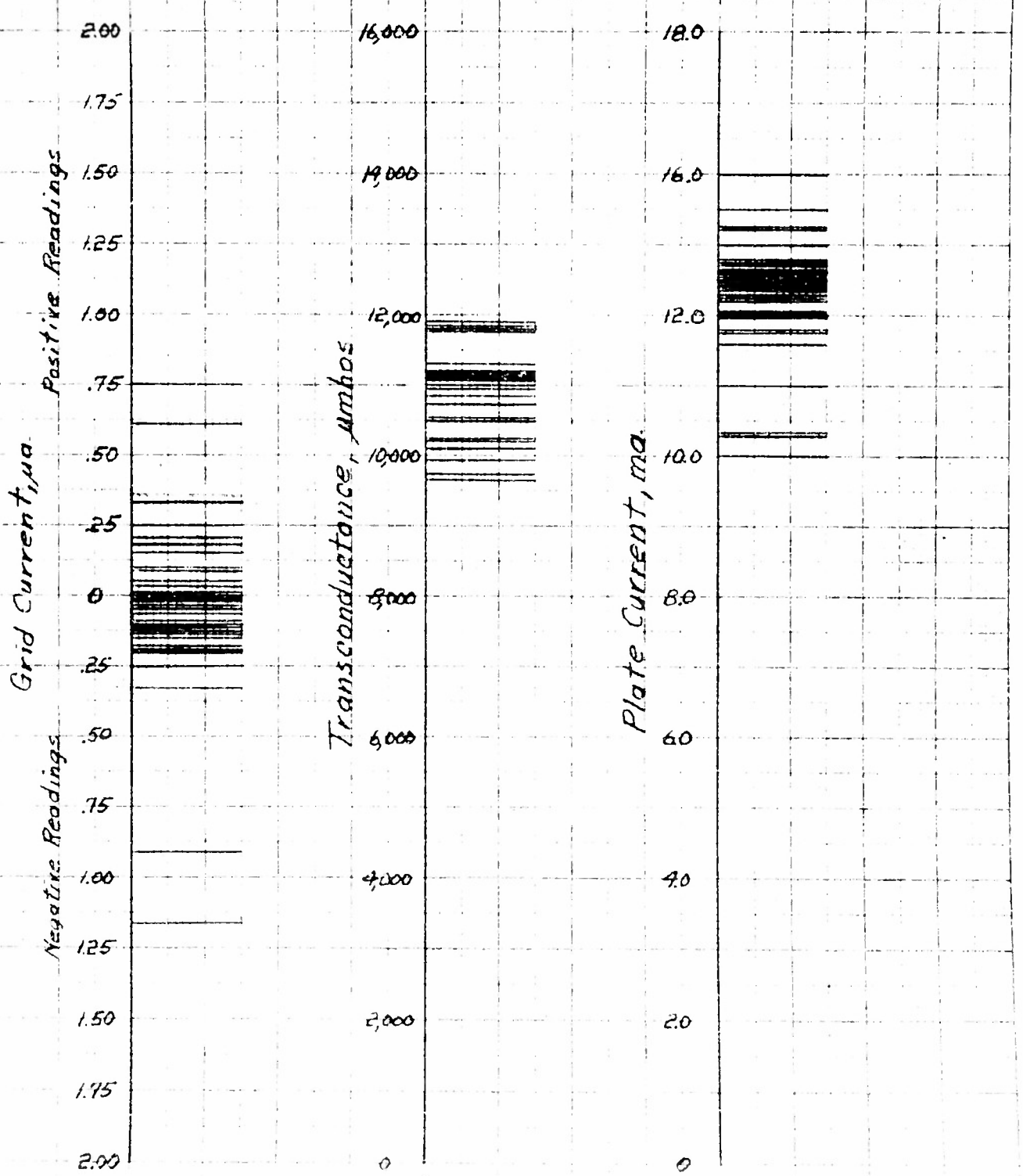
Distribution Diagram for Getterless Type Construction

Tubes Sealed 12-16-53 N=30 Readings Made 2-9-54



Distribution Diagram for Getterless Type Construction

Tubes Sealed 12-16-53 N=30 Readings Made 2-9-54



Appendix B

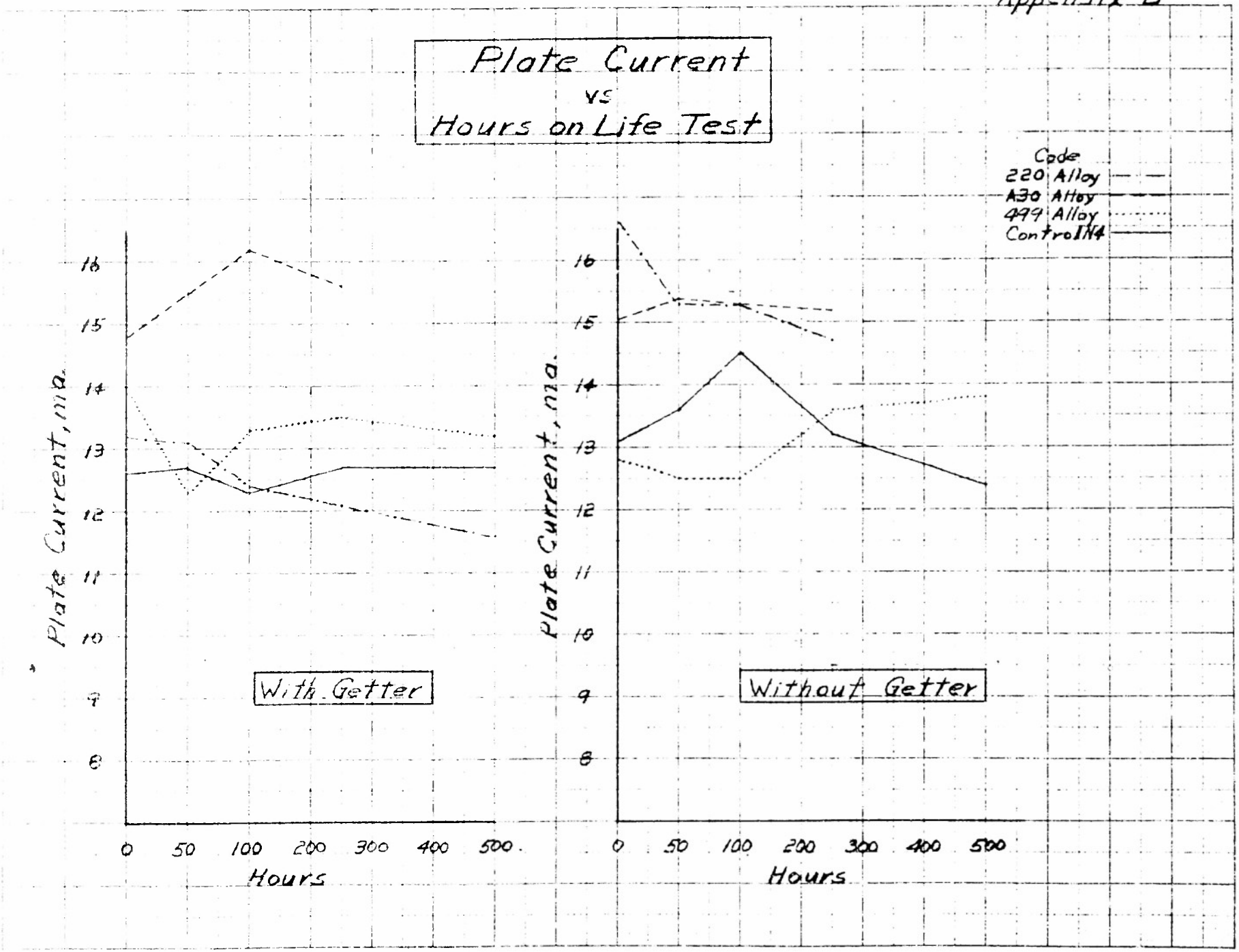
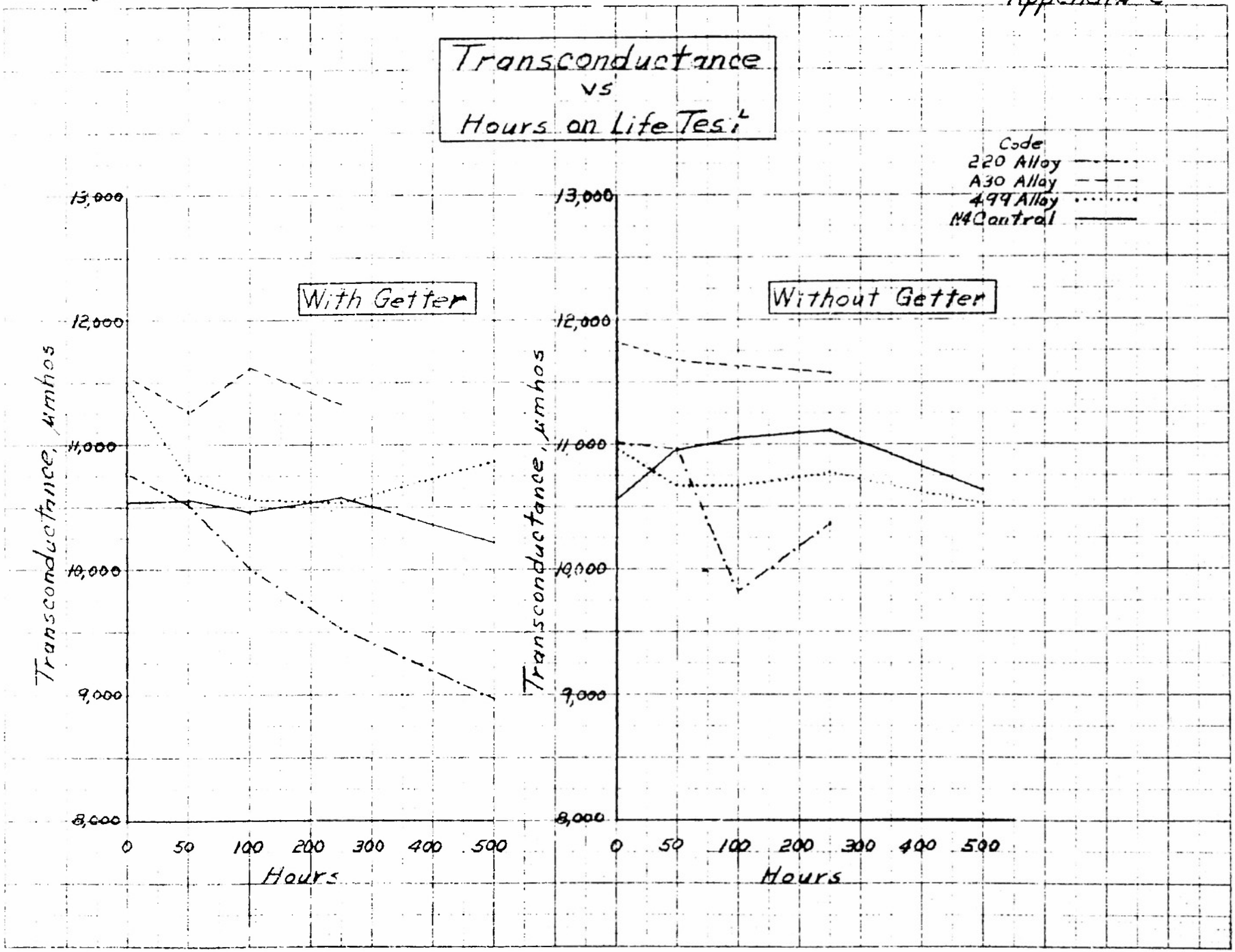
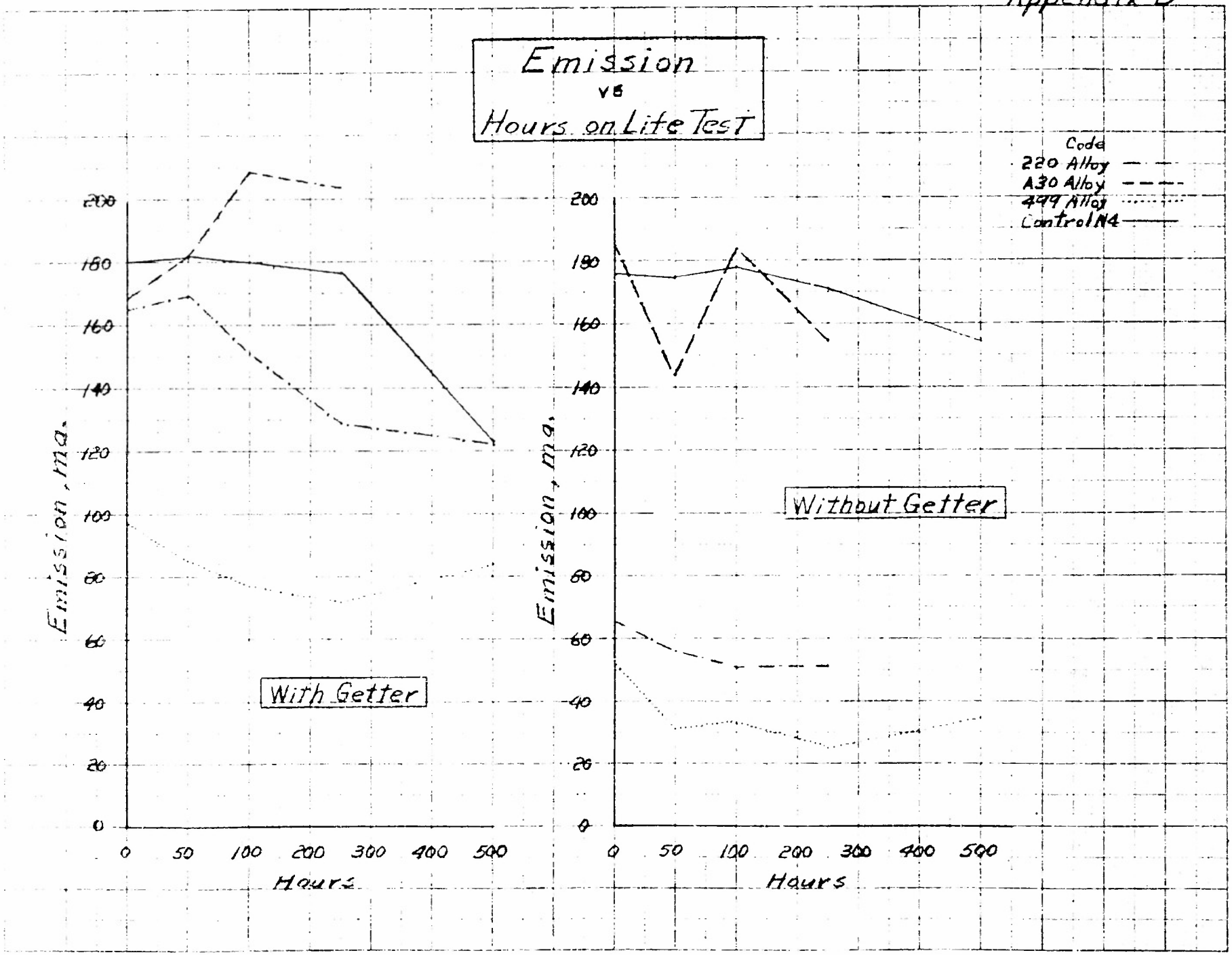
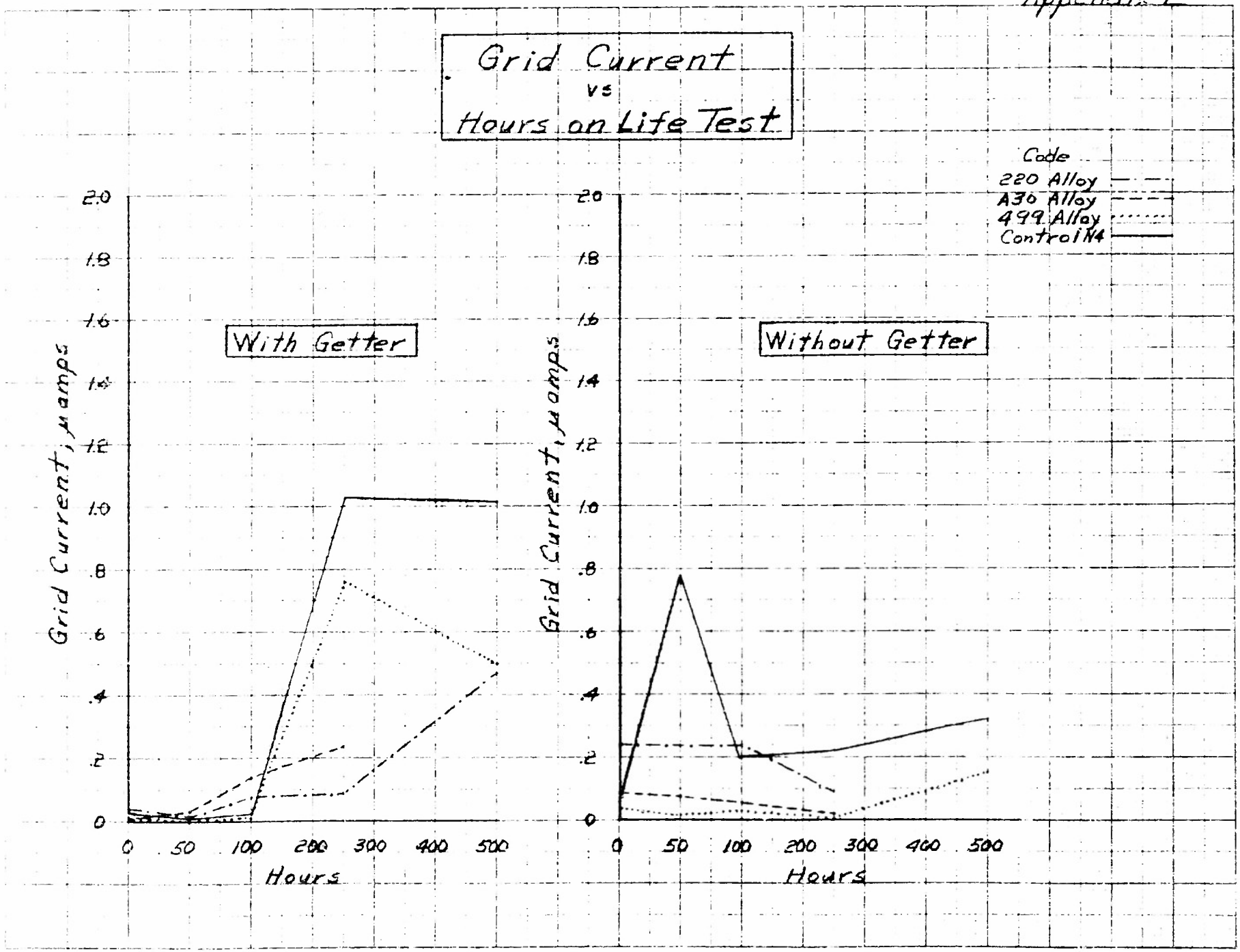


Plate Current
vs
Hours on Life Test
Code
220 Alloy
A30 Alloy
499 Alloy
Control
Plate Current, ma.
16
15
14
13
12
11
10
9
8
With Getter
0
50
100
200
300
400
500
Hours
Without Getter


Transconductance
vs
Hours on Life Test
Code
220 Alloy
A30 Alloy
499 Alloy
N4 Control
With Getter
Without Getter
Transconductance, μmhos
13,000
12,000
11,000
10,000
9,000
8,000
0
50
100
200
300
400
500
Hours

Appendix D


Emission
vs
Hours on Life Test
Code
220 Alloy
A30 Alloy
499 Alloy
Control N4
With Getter
Without Getter
Emission, ma.
Hours
0
20
40
60
80
100
120
140
160
180
200
0
50
100
200
300
400
500


Grid Current
vs
Hours on Life Test
Code
220 Alloy
A30 Alloy
499 Alloy
Control N4
With Getter
Without Getter
Grid Current, μamps
Hours
0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
50
100
200
300
400
500

Insulation Resistance

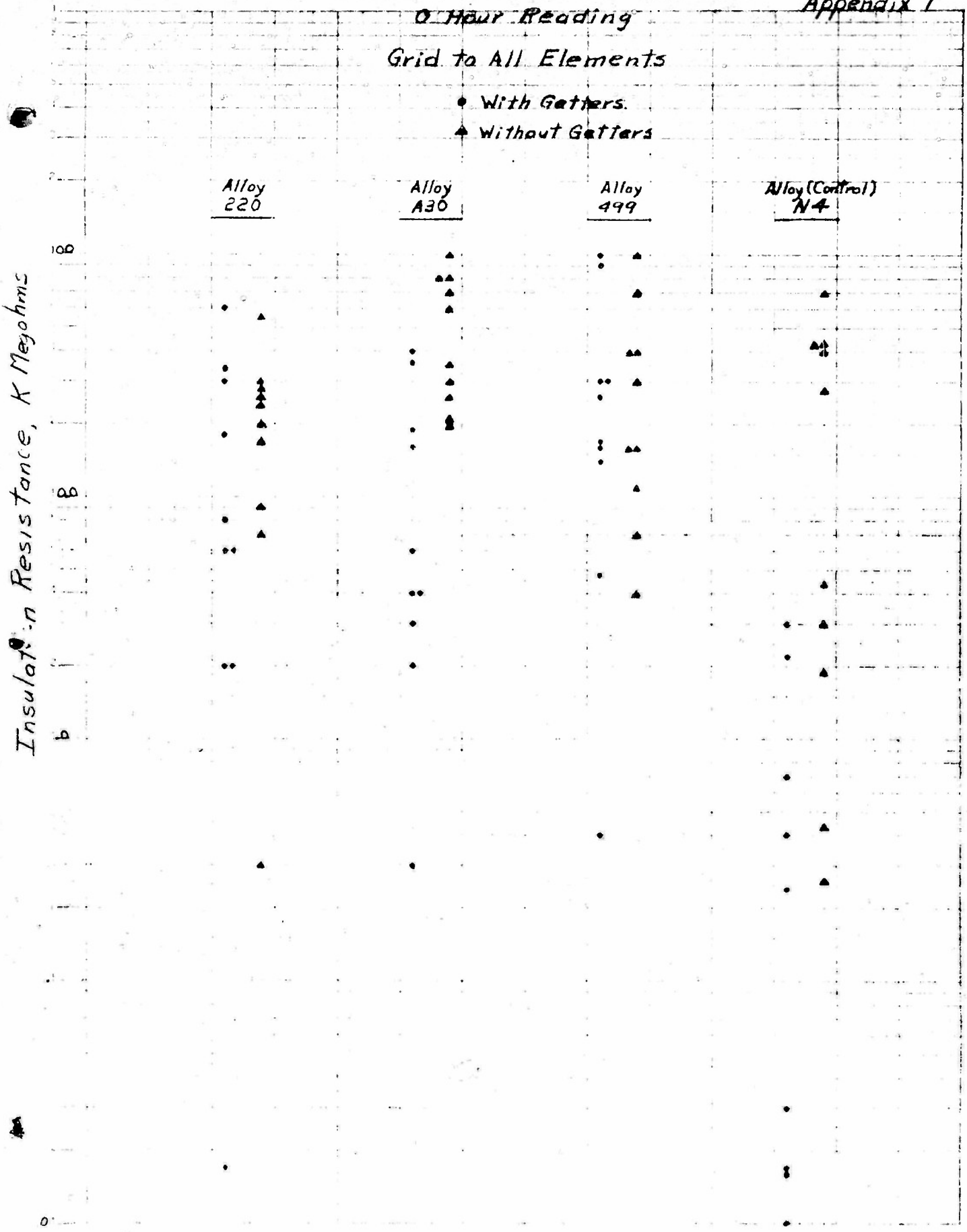
Appendix F

0 Hour Reading

Grid to All Elements

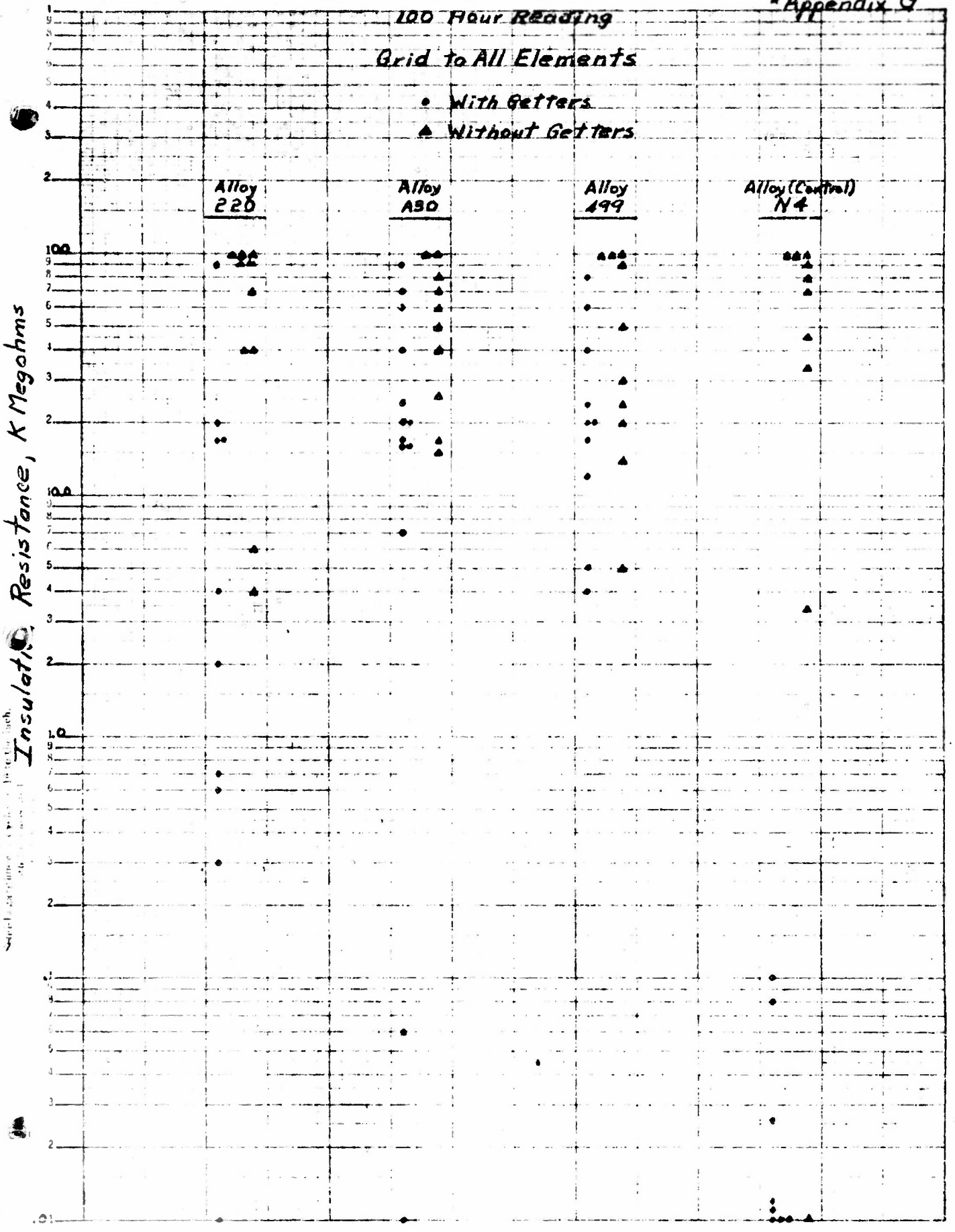
● With Getters.

▲ Without Getters



Insulation Resistance

Appendix G



Appendix H

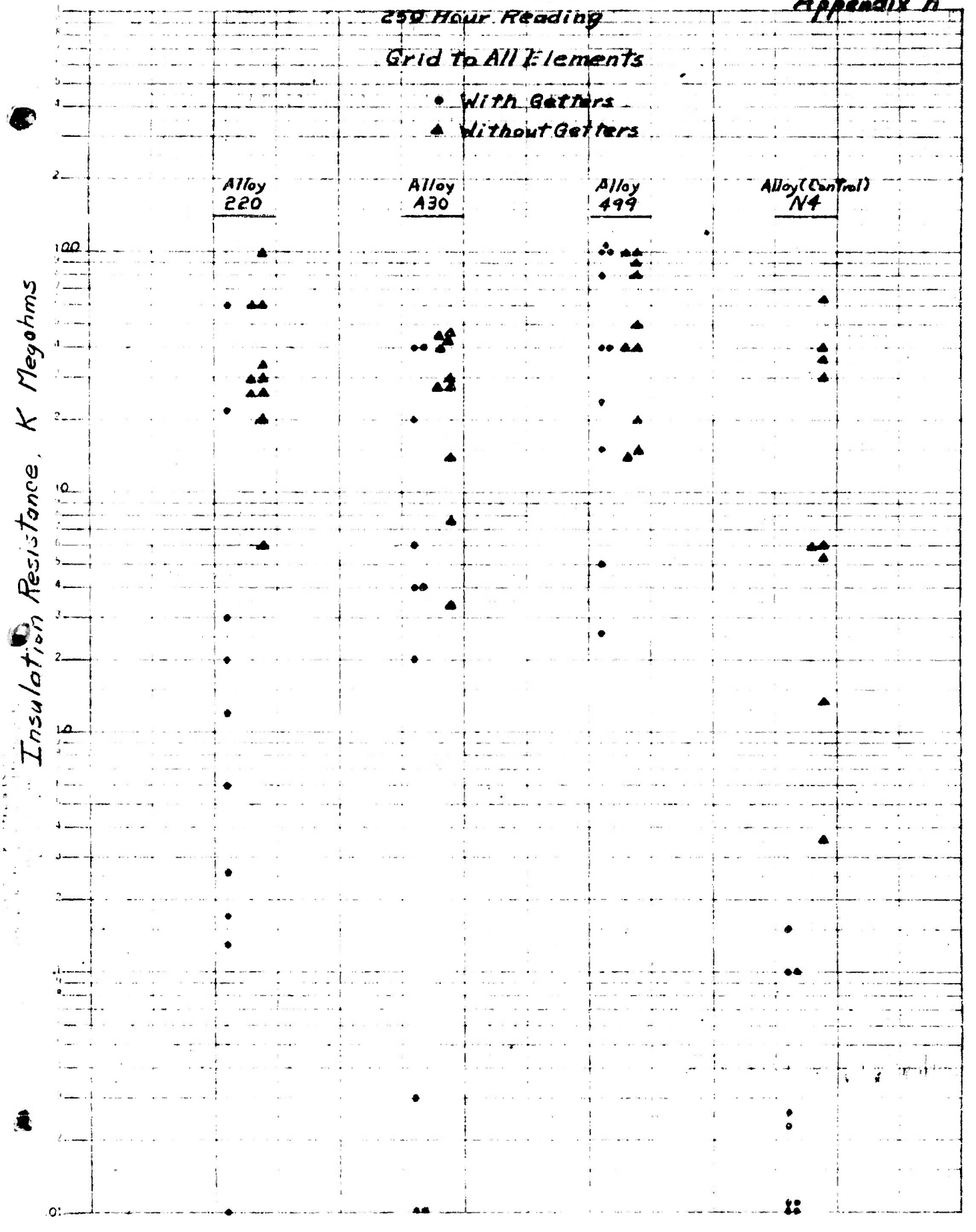
Insulation Resistance

250 Hour Reading

Grid to All Elements

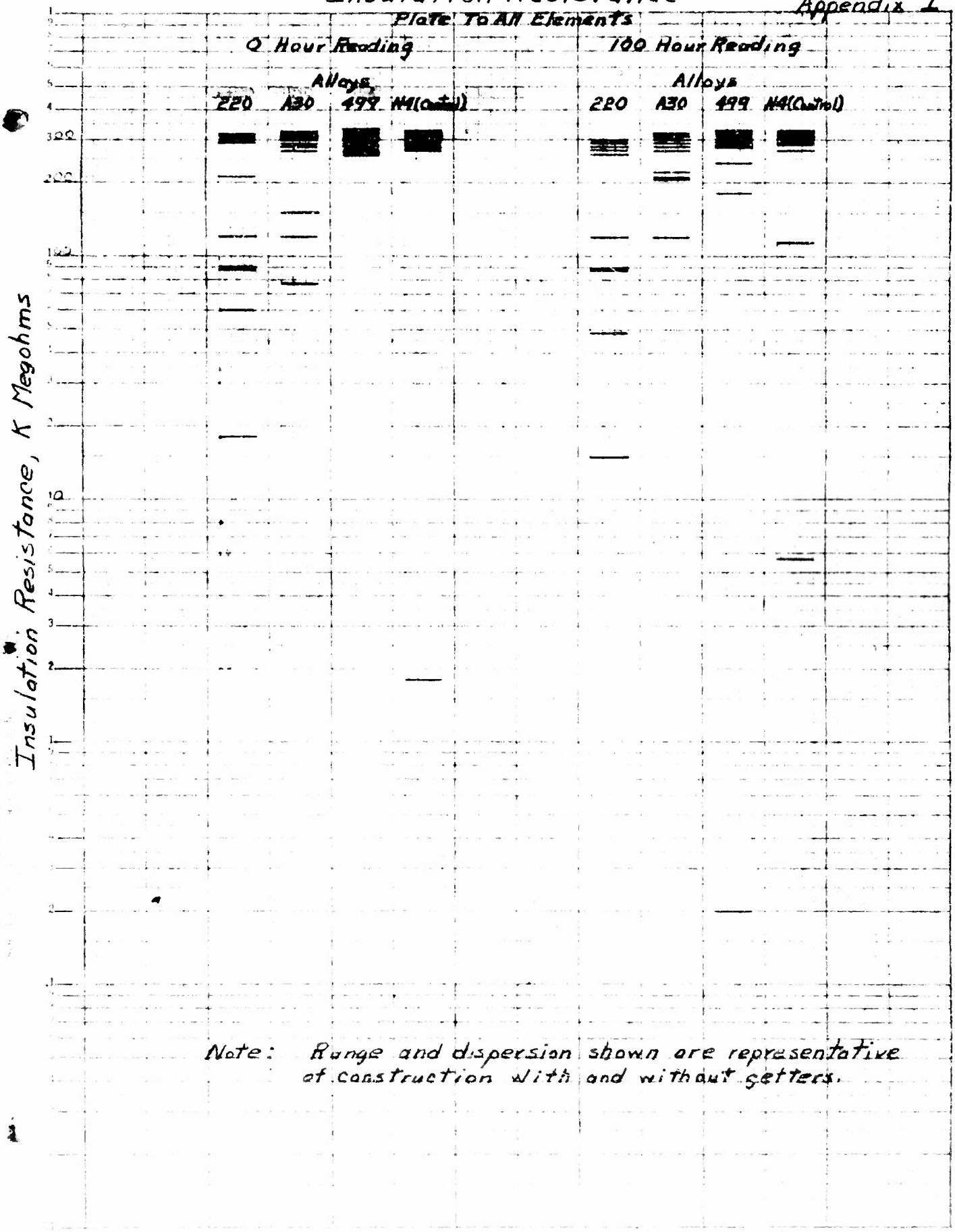
• With Getters

▲ Without Getters



Insulation Resistance

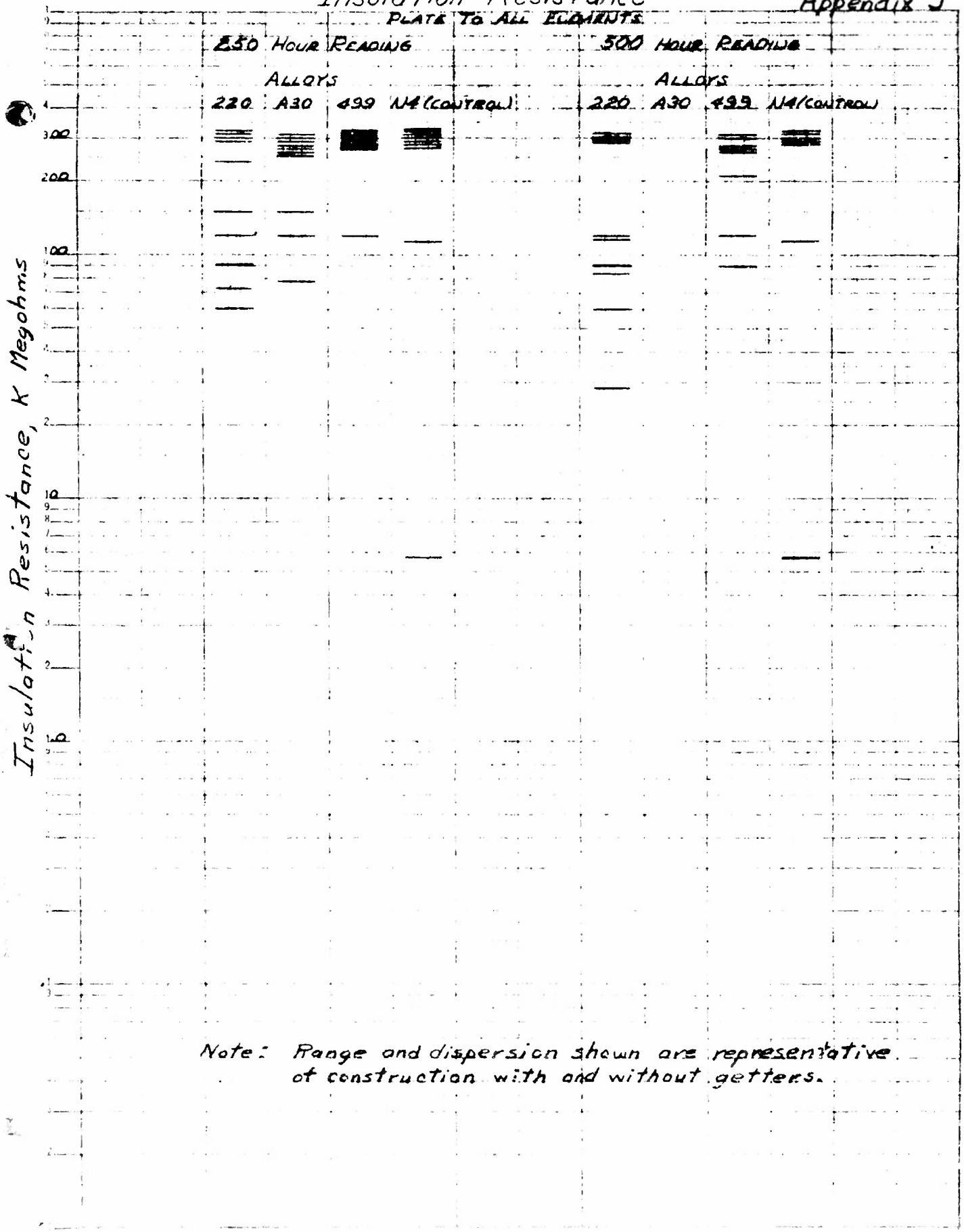
Appendix I



Note: Range and dispersion shown are representative of construction with and without getters.

Insulation Resistance

Appendix J



Note: Range and dispersion shown are representative of construction with and without getters.

Appendix K

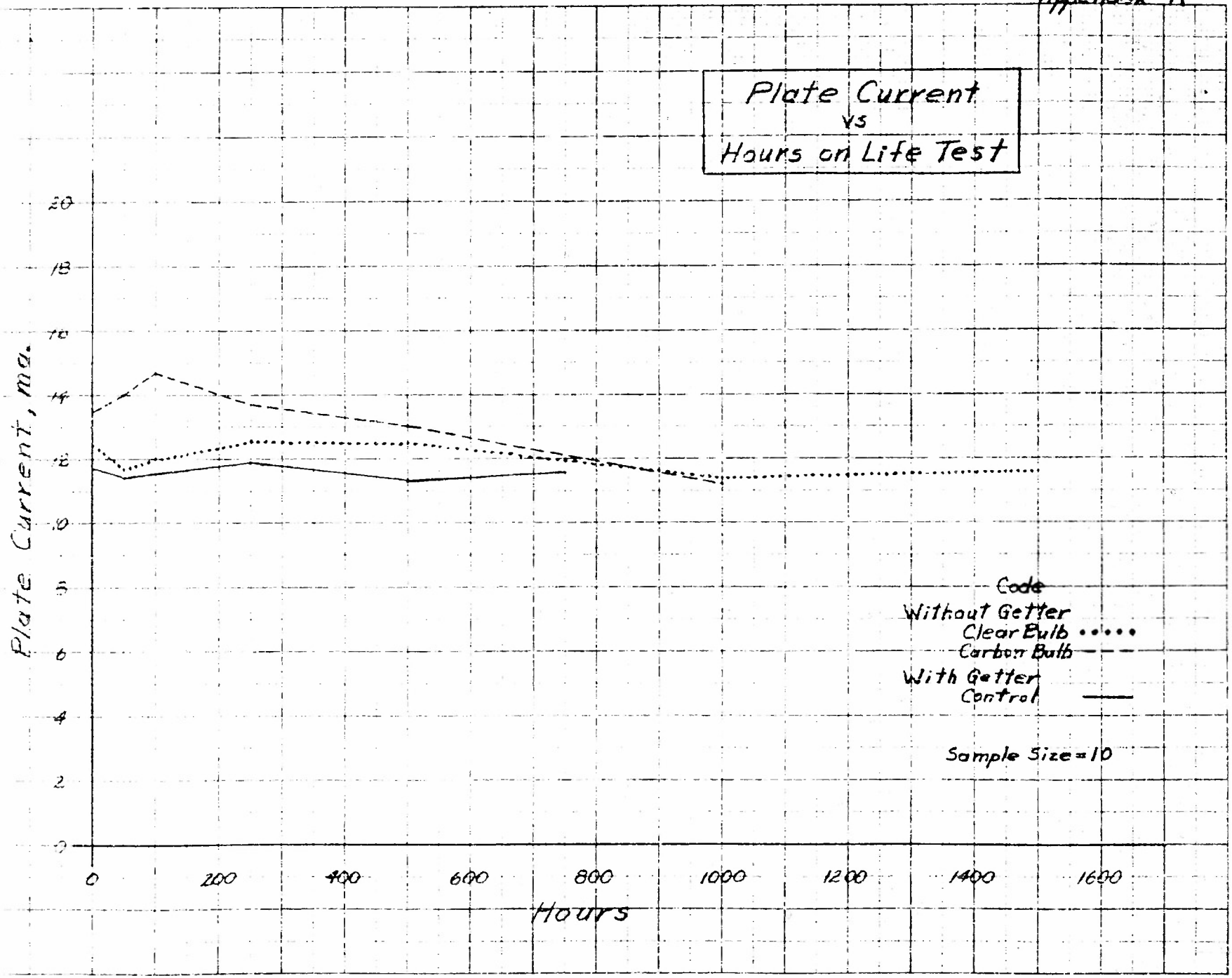
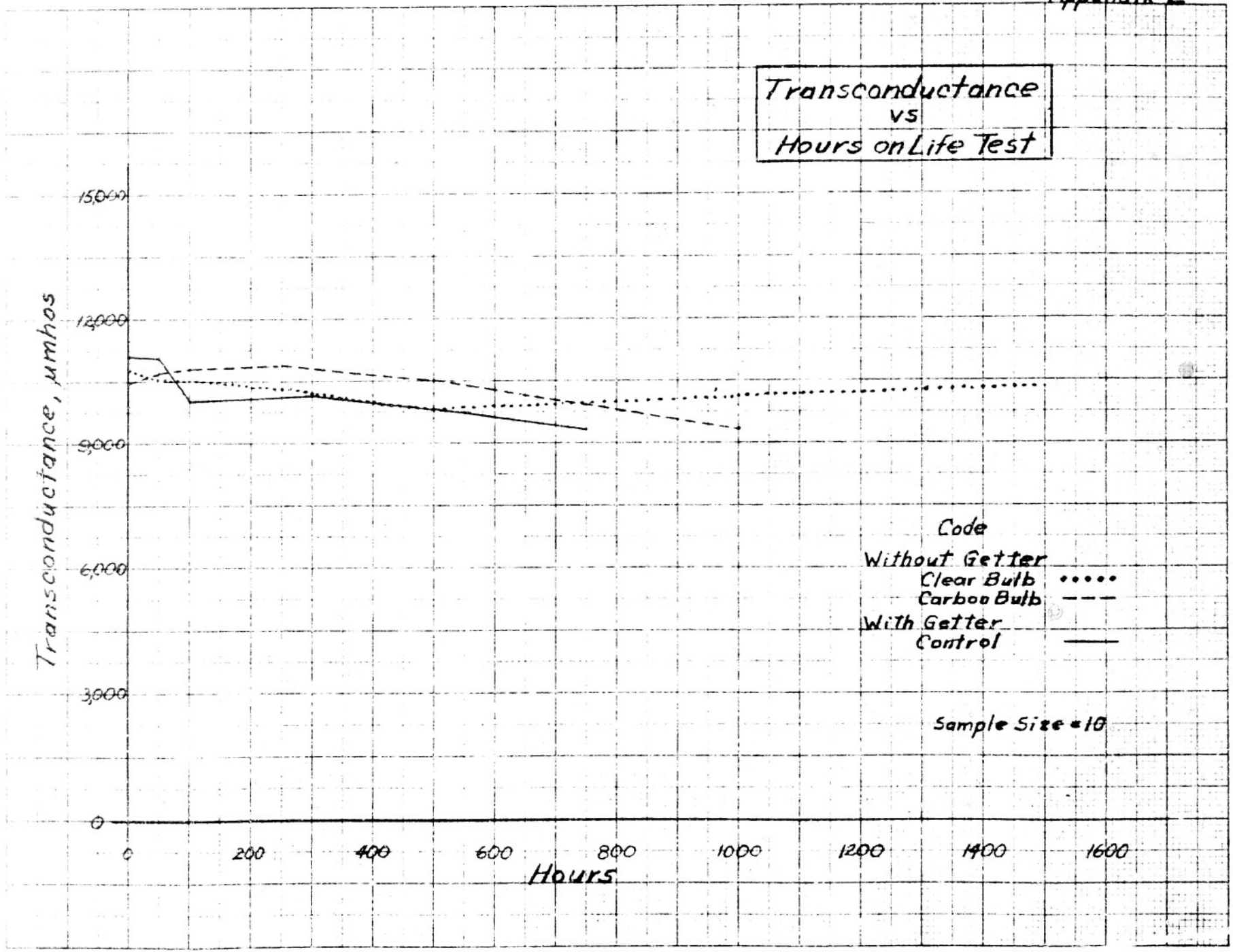
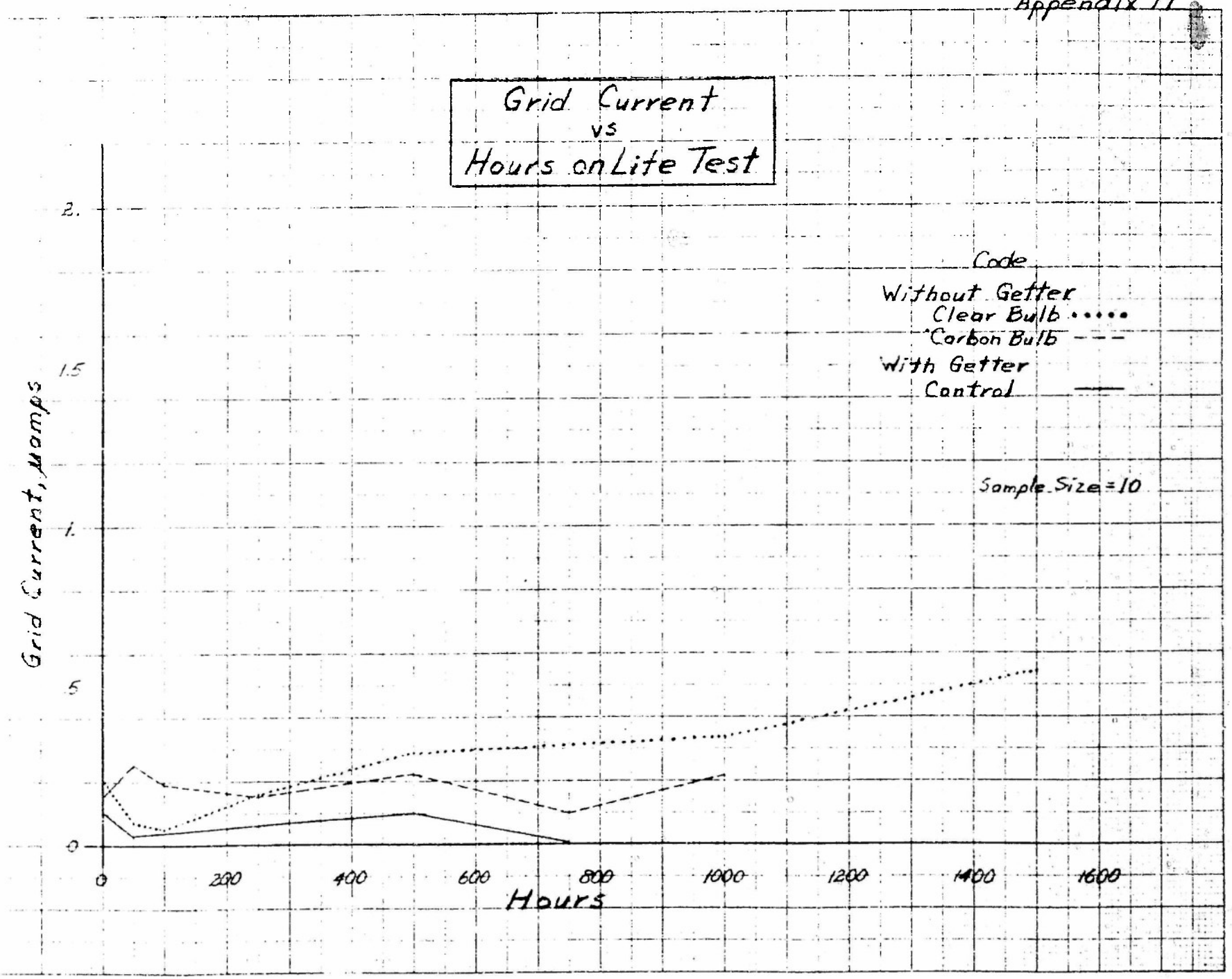


Plate Current
vs
Hours on Life Test
Plate Current, ma.
20
18
16
14
12
10
8
6
4
2
0
0
200
400
600
800
1000
1200
1400
1600
Hours
Code
Without Getter
Clear Bulb
Carbon Bulb
With Getter
Control
Sample Size = 10

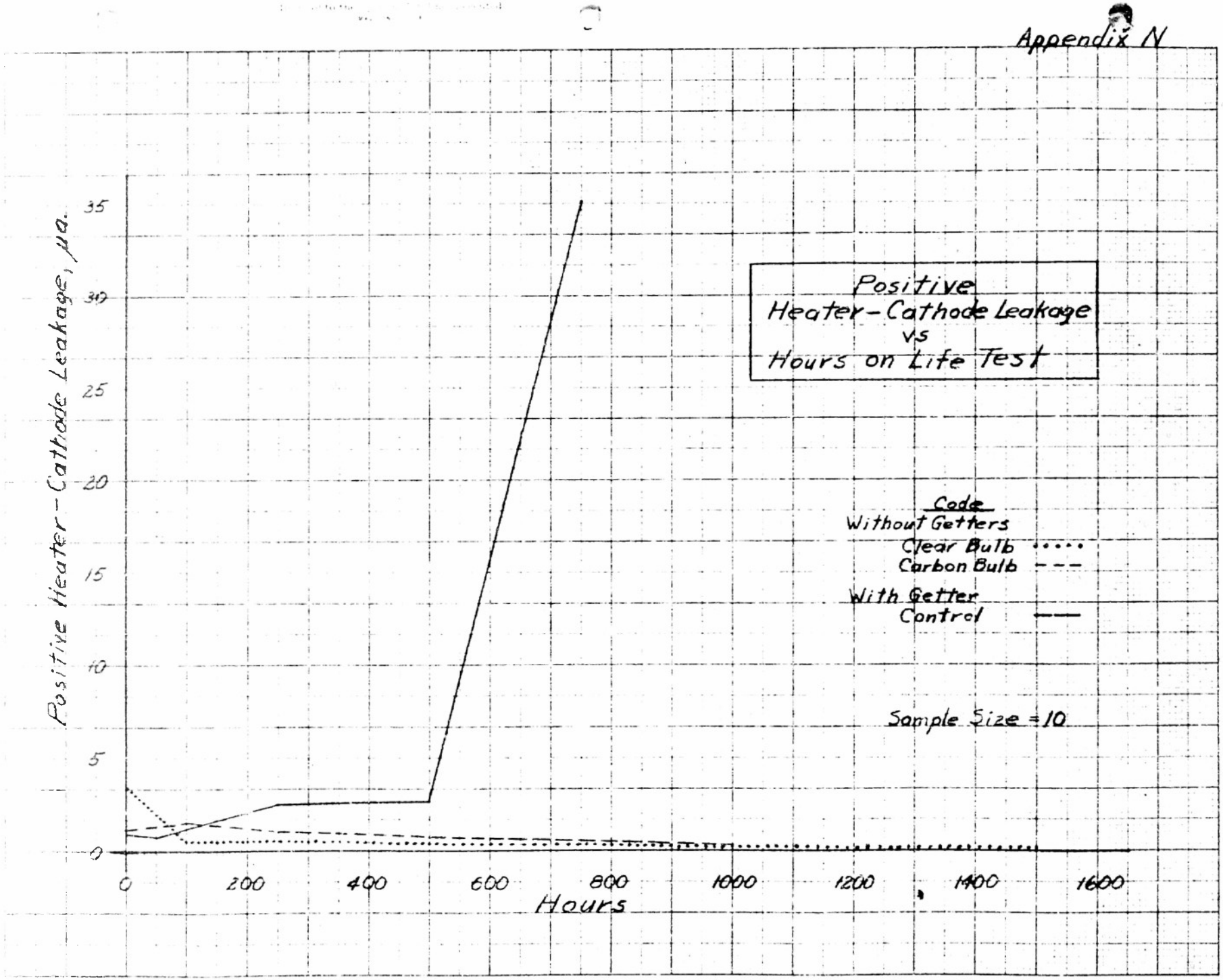
Appendix L

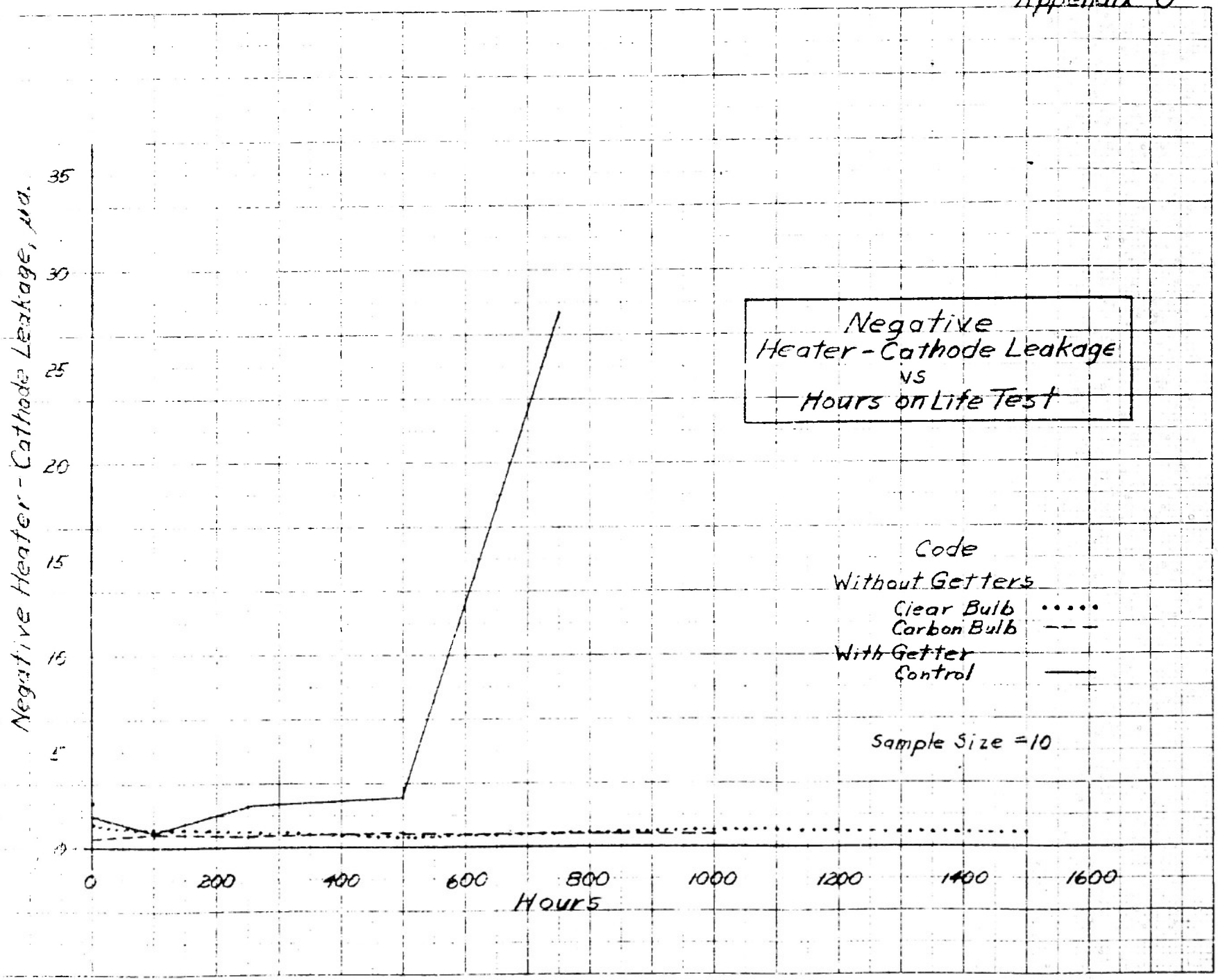

Transconductance
vs
Hours on Life Test
Transconductance, μmhos
15,000
12,000
9,000
6,000
3,000
0
0
200
400
600
800
1000
1200
1400
1600
Hours
Code
Without Getter
Clear Bulb
Carboo Bulb
With Getter
Control
Sample Size = 10

Appendix M


Grid Current
vs
Hours on Life Test
Code
Without Getter
Clear Bulb .....
Carbon Bulb - - -
With Getter
Control ——
Sample Size = 10
Grid Current, Microamps
2.
1.5
1.
5
0
0
200
400
600
800
1000
1200
1400
1600
Hours

Appendix N

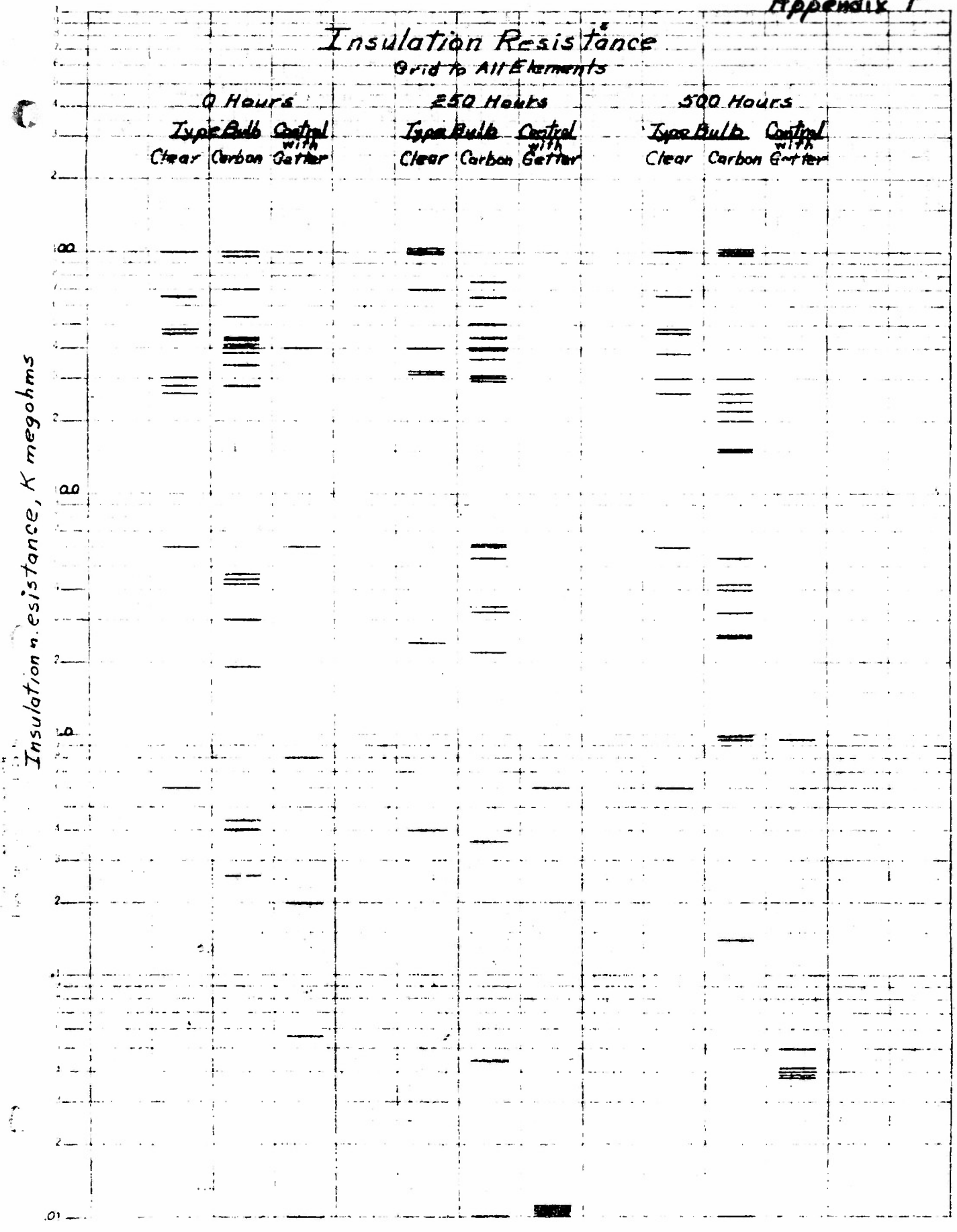

Positive Heater-Cathode Leakage, μa.
35
30
25
20
15
10
5
0
0
200
400
600
800
1000
1200
1400
1600
Hours
Positive
Heater-Cathode Leakage
vs
Hours on Life Test
Code
Without Getters
Clear Bulb
Carbon Bulb
With Getter
Control
Sample Size = 10


Negative Heater - Cathode Leakage, μa.
35
30
25
20
15
10
5
0
0
200
400
600
800
1000
1200
1400
1600
Hours
Negative
Heater - Cathode Leakage
VS
Hours on Life Test
Code
Without Getters
Clear Bulb
Carbon Bulb
With Getter
Control
Sample Size = 10

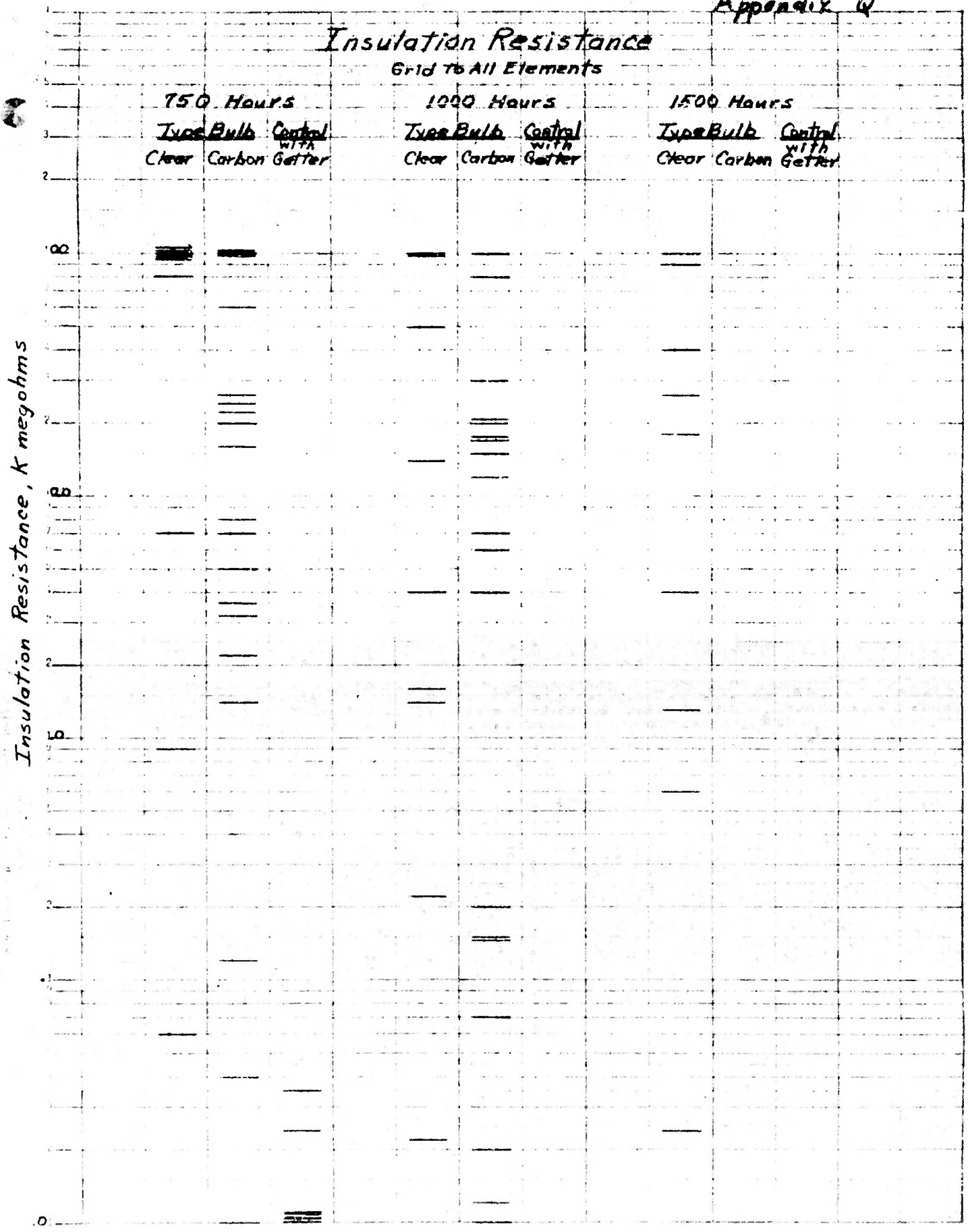
Appendix P

Insulation Resistance

Grid to All Elements



Appendix Q


Insulation Resistance
Grid To All Elements
750 Hours
1000 Hours
1500 Hours
Type Bulb
Clear
Carbon
Control with Getter
Insulation Resistance, K megohms

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